PICTURE SEGMENT CODING WITH MOTION PREDICTION

The present invention relates to coding and more specifically to video source coding for wireless transmission.

BACKGROUND OF THE INVENTION

Wireless transmission is characterized by a relatively low transmission bit rate and a high error rate. Where the transmission bit rate is concerned, a low bit rate means bit rate values less than 100 kbit/s, for example GSM channels at 14 kbit/s. High error rates means error rates greater than 10^{-6}, or even greater than 10^{-4}.

The ITU-T H.263+ standard proposes solutions for video source coding. The standard comprises an obligatory common part and a set of optional appendices which can be implemented in addition to the common part of the standard. The standard gives no indication as to the quality of the pictures obtained or the combination of appendices that apply in given circumstances, in particular for wireless transmission. Implementing all the appendices yields a system that is difficult to apply to wireless transmission because of the low transmission bit rate available and the error rate.

The common part of the H.263+ standard proposes block coding with prediction. A distinction is made in a sequence of pictures between pictures that are transmitted integrally (referred to as "I" pictures), pictures that are not transmitted integrally but predicted from a preceding picture (referred to as "P" pictures), and pictures that are not transmitted integrally but which are predicted from a preceding picture and a succeeding picture. The coding process uses the following steps for a picture including blocks or macroblocks made up of a plurality of blocks, typically six blocks, of which four are luminance blocks and two are chrominance blocks:

- estimating motion of blocks or macroblocks of each

picture,

- predicting motion compensation relative to a reference picture, and
- coding for transmission, typically by coding with compression (including discrete cosine transform (DCT), quantizing and variable length coding (VLC)).

Appendix R of the above standard, entitled "Independent segment decoding mode", proposes to use video picture segments made up of a set of blocks for motion estimation processing; motion is estimated independently in each segment. In this case, the boundaries of a segment are treated as boundaries of the picture for the purposes of decoding, including for the purposes of processing motion vectors that cross boundaries. Motion vectors that cross boundaries are prohibited in the absence of the optional modes of appendix D, F, J and O. If the unrestricted motion vector mode of appendix D is used, the boundaries of the current video picture segment are extrapolated to constitute predictions of pixels outside segment regions.

Appendix N of the standard, entitled "Unrestricted motion vector mode", proposes an exception to the principle stated in the common part of the standard, whereby motion vectors are restricted so that all the pixels to which they refer are in the coded area of the picture. To be more specific, appendix N proposes that motion vectors be allowed to point outside the picture. If a pixel to which a motion vector refers is outside the coded picture surface, an edge pixel is used in its place. The value of the edge pixel is obtained by limiting the motion vector to the last position corresponding to an entire pixel within the coded picture surface. Motion vector limitation is based on one pixel and is implemented separately for each component of the motion vector.

Other appendices propose that the motion vectors be allowed to cross the boundaries of a picture or picture

segment. This applies to appendices F, entitled "Advanced prediction mode", J, entitled "Deblocking filter mode", and O, entitled "Temporal, SNR and spatial scalability".

OBJECTS AND SUMMARY OF THE INVENTION

The invention proposes a solution to the problem of transmission at low bit rates with high errors rates. The problem of the effects of block coding and motion vector limitation arises in this particular context. It arises in a specific and acute manner in the context of transmission at low bit rates and with high error rates in that the errors that occur are difficult to correct by retransmission or by means of an error-correcting code, because of the time-delay this would cause. Also, the low bit rate cannot be compensated by a lower number of errors.

This problem arises in a particular manner for macroblocks on the right-hand side and at the top edge of a segment, because of predictive coding, and more specifically because of the macroblock scanning direction: it is standard practice to determine motion vectors by scanning the picture from left to right and top to bottom.

One effect of segment coding as proposed in appendix R is to limit the effect of transmission errors. From this point of view, appendix R strictly applies to the particular context of transmission at low bit rates, and is contrary to the suggestion in appendix R of envisaging that motion vectors be allowed to leave the frame of the segment in the context of transmission at low bit rates.

The invention therefore proposes a picture coding method for transmission on a channel at a low bit rate and with a high error rate, which method uses motion estimation coding and divides the picture into a plurality of segments made up of macroblocks, wherein, at least for an edge block of a segment, a motion estimation vector is allowed to extend into an adjacent segment.

In one embodiment, for an edge macroblock of a segment, a motion estimation vector is allowed to extend into an adjacent macroblock of the adjacent segment.

For motion vector estimation the picture is preferably scanned from left to right and from top to bottom and, for macroblocks adjacent the top edge of a segment, a motion estimation vector is allowed to extend into an adjacent segment.

If, for motion vector estimation, the picture is scanned from left to right and from top to bottom, it is also advantageous, for macroblocks adjacent the right-hand edge of a segment, for a motion estimation vector to be allowed to extend into an adjacent segment.

In one embodiment, each segment is made up of two groups of blocks.

The invention applies in particular if the error rate is greater than 10^{-6}, or even greater than 10^{-4}, or if the transmission rate is less than 100 kbit/s.

The invention further proposes a coder implementing the above method. It also proposes a transmission system using a channel at a low bit rate and with a high error rate, the system including the above coder.

BRIEF DESCRIPTION OF THE DRAWINGS

Other features and advantages of the invention will become apparent on reading the following description of embodiments of the invention, which description is given by way of example and with reference to the accompanying drawings, in which:

- Figure 1 is a diagram showing one definition of video picture segments in a picture, and
- Figure 2 is a diagram showing a coder according to the invention.

MORE DETAILED DESCRIPTION

The invention applies to motion vector coding transmission systems and is of particular benefit in the specific context of transmission systems operating at low bit rates and with high errors rates (these terms are

defined above). If picture segments are defined for estimating motion vectors, the invention proposes to allow motion vectors for blocks or macroblocks defining the edge of the picture to overflow into the adjoining segments.

Figure 1 is a diagram showing one definition of video picture segments in a picture. In the example, the picture is a QCIF picture and each segment is made up of two lines of macroblocks, limited by a synchronization signal. Each macroblock consists of four luminance blocks and two chrominance blocks, and each block consists of an 8×8 square of pixels. Synchronization is used not only to separate the segments but also to enable the decoder to resynchronize in the event of a transmission error in a segment. Separation into segments prevents transmission errors propagating over the whole picture.

In the example, each segment is made up of two lines of macroblocks Mbi. The lines of macroblocks are referred to as "group of blocks" GOBi. Each line of macroblocks is made up of eleven macroblocks and the picture is divided into nine groups of blocks, i.e. into four and a half segments for a picture comprising 176×144 luminance pixels. As shown in the figure, each segment is separated from adjacent segments by a synchronization signal.

According to appendix R of the H.263+ standard, which is discussed above, motion vectors are estimated inside segments. This solution has the advantage of limiting propagation errors, because each segment is coded independently of the adjacent segments. This solution is satisfactory, but has limitations in the context of transmission at low bit rates and with high error rates.

The invention proposes to relax this constraint on estimating motion vectors of edge macroblocks of a segment. To be more specific, when motion vectors are

estimated by scanning the picture from left to right and from top to bottom, the motion estimation problem arises for the macroblocks that form the top and right-hand edges of each segment. Pixels top left and top right of the current pixel are then used for motion estimation; motion estimation within the segment is correct for the macroblocks on the left-hand side of the segment or at the bottom edge of the segment (for segments of more than two lines of macroblocks). However, motion vector limitation causes a problem for macroblocks at the top or right-hand edge of the segment. The invention proposes that the vector be allowed to have one end in one of the adjacent macroblocks of the adjacent segment.

The example shown in the figure considers the segment formed of the groups of blocks GOB4 and GOB5. That segment is limited at the top by a synchronization signal Sync4 and at the bottom by a synchronization signal Sync5. Consider macroblock MBx of the group of blocks GOB4. It is one of the edge macroblocks of the segment. For estimating motion vectors of the pixels or blocks of the macroblock, the invention therefore proposes using not only the other macroblocks of the segment but also, where applicable, macroblocks of the segment formed of the groups of blocks GOB2 and GOB3. To be more specific, it is advantageous to use only adjacent macroblocks, in other words the macroblocks of group GOB3, or to be more specific the macroblocks MBx-1, MBx and MBx+1 of group GOB3.

Figure 1 shows the line jlow which separates the groups of blocks GOB2 and GOB3 and the line jhigh which separates the groups of blocks GOB5 and GOB5. In this case, the macroblocks between the lines jlow and jhigh can be used to estimate the motion of a macroblock at the top edge of the segment, i.e. a macroblock of the group GOB4. The distance between the line jlow and the synchronization signal Sync4 is fifteen pixels.

The invention applies more particularly to the

macroblocks on the right-hand side of a segment, as in the previous context of scanning the picture from left to right and top to bottom. In this case, if the motion vector were not allowed to cross the top edge of the segment, it would tend to be stretched horizontally, which would cause it to leave the picture. The invention avoids this problem. It is therefore particularly advantageous to apply the invention to the top right macroblock of the segment. In the Figure 1 example this is the macroblock MB10 of the group of blocks GOB4 for the segment consisting of the groups GOB4 and GOB5.

For transmission at low bit rates with high error rates, the invention avoids errors caused by limiting the motion estimate to one segment. It improves the quality of the reconstructed picture and does not interfere with the constraints encountered in transmission at low bit rates and with high error rates, namely the transmission speed and the complexity and memory capacity of the coder or decoder. Because the motion vector estimate is nevertheless limited, the invention has the advantages of appendix R, i.e. it limits the propagation of errors.

The foregoing description does not specify which picture is the reference picture; the reference picture can be chosen in a manner that is known in the art, and can simply be the preceding picture, as in the Figure 2 coder example.

Figure 2 is a diagram showing a predictive coding system according to the invention. The video pictures at the input of the coding system are applied to a motion estimator 2 and to an input of a subtractor 4. The motion estimator supplies an estimate of the motion of blocks or macroblocks of the picture relative to the preceding picture; blocks of 8×8 pixels and macroblocks comprising six blocks, four of which are luminance blocks and two of which are chrominance blocks, can be used, as proposed in the standard.

In accordance with the invention, the motion

estimator uses picture segments as proposed in appendix R. The motion vectors are then estimated inside the segment. However, as explained above, and at least for the edge blocks, the estimator uses motion vectors that are allowed to leave the segment.

The motion vectors of the blocks are transmitted to a motion compensation predictor 6. To produce an estimate the predictor also receives at its input a basic picture from a reference picture memory 8. Prediction with motion compensation is effected relative to the reference picture.

The motion compensation predictor supplies an estimated picture which is based on the reference picture and motion vectors and is fed to a subtract input of the subtractor 4 and to an input of an adder 10.

The subtractor 4 therefore receives the input video picture and an estimated picture based on a reference picture contained in the basic picture memory. The estimated picture is subtracted from the video picture fed to the input in a compression coder 12, typically a discrete cosine transform coder. Quantizing is then carried out in a quantizer 14, preferably with a variable quantizing step. The output of the quantizer 14 is applied to a variable length coder 16 and to a quantizing inverter 18, which carries out the converse operation. The converse of the transform applied by the decoder 12 is applied at the output 20 of the quantizing inverter 18. The difference between the input picture and the estimated picture, as reconstituted after reception in the associated decoding system shown in Figure 2, and in the absence of transmission errors, is obtained at the output of the coding inverter 20. This difference is fed to input of the adder 10. The adder 10 therefore outputs to the reference picture memory a picture such as could be obtained after reception in the decoding system, possibly affected by transmission errors.

The variable length coder receives the outputs of

the coder 14 and the motion estimator 2, in other words the difference between the input picture and the estimated picture and the motion vectors. The output of the VLC is fed to a video buffer 22 before transmission over the channel; of course, the video signal could be multiplexed with audio or other signals before transmission; this is known in the art and has no effect on the functioning of the invention. If the quantizing step is variable, the quantity of information in the buffer can be used to control the quantizing step, as shown in Figure 3 by an arrow connecting the buffer 22 to the quantizer 14.

The coder in accordance with the invention differs from a prior art coder in that the motion estimator also considers macroblocks outside the current segment, for example macroblocks in the adjacent groups of blocks. Note that the coder for decoding signals supplied by the coder in accordance with the invention does not differ from a prior art decoder.

Of course, the present invention is not limited to the examples and embodiments described and shown, many variants of which will suggest themselves to the skilled person. It is clear that the definition of the macroblocks or segments given above is merely one example, and that the invention also applies to other definitions of picture segments, blocks and macroblocks. Thus the picture could be divided into vertical segments, in which case the scanning direction and the macroblocks to which the invention would be applied could change.